

We Claim:

1. A feed-forward amplifier, comprising a signal cancellation loop and an intermodulation cancellation loop, the feed-forward amplifier configured to operate so that on start-up the signal cancellation loop is balanced so as to minimize signal power in the feed-forward path and thereafter is operated so as to minimize intermodulation at the output of the feed-forward amplifier.

2. A feed-forward amplifier, comprising:

an input port 16;

an output port 18;

a first main path splitter 20, the input of which is connected to the input port 16 so that when an input signal applied to the input port 16 it is split by the first main path splitter 20 into a main signal and a feed-forward signal;

a main signal path gain and phase adjuster 22, the input of which is connected to the first output of the first main path splitter 20, the main signal path gain and phase adjuster 22 having a gain-control input tap T_1 and a phase-control input tap T_2 configured so that the voltage levels on the taps control the gain and phase of the main signal;

a main amplifier 24, the input of which is connected to the output of the main signal path gain and phase adjuster 22;

a second main path splitter 26, the input of which is connected to the output of the main amplifier 24;

a main signal path delay element 28, the input of which is connected to the first output of the second main path splitter 26,

a first main path coupler 30, the first input of which is connected to the output of the main signal path delay element 28;

a third main path splitter 32, the input of which is connected to the output of the first

main path coupler 30 and the first output of which is connected to the output port 18;

an intermodulation receiver 44, the input of which is connected to the second output of the third main path splitter 32,

a feed-forward signal path delay element 34, the input of which is connected to the second output of the first main path splitter 20, the delay imposed by the feed-forward signal path delay element 34 selected to approximately match the delay in the main signal caused by the main amplifier 24;

a feed-forward path coupler 36, the first input of which is connected to the output of the feed-forward signal path delay element 34;

an attenuator 43 connecting the second output of the second main path splitter 26 to the second input of the feed-forward path coupler 36, the attenuation selected so that the undistorted portion of the main signal provided to the feed-forward path coupler 36 is approximately cancelled out by the feed-forward signal;

a feed-forward path splitter 38, the input of which is connected to the output of the feed-forward path coupler 36;

an SPDT switch 46, the first throw of which is connected to the second output of the feed-forward path splitter 38 and the second throw of which is connected to the output of the intermodulation receiver 44;

a signal-power detector/processor 48, the input of which is connected to the pole of the SPDT switch 46, the signal-power detector/processor 48 configured to extract and process data from the signal presented to its input indicating how to steer the gain-control input tap T_1 and the phase-control input tap T_2 to minimize the signal presented to its input;

a signal-power gain controller 52, the input of which is connected to the first output of the signal-power detector/processor 48, the signal-power gain controller 52 configured to steer the gain-control input tap T_1 in response to data provided by the signal-power detector/processor 48 to minimize signal power at the feed-forward path splitter 38 when the SPDT switch 46 is set to connect the input of the signal-power detector/processor 48 to the second output of the feed-

forward path splitter 38 and to minimize the intermodulation received by the intermodulation receiver 44 when the SPDT switch 46 is set to connect the input of the signal-power detector/processor 48 to the output of the intermodulation receiver 44;

a signal-power phase controller 54, the input of which is connected to the second output of the signal-power detector/processor 48, the signal-power phase controller 54 configured to steer the phase-control input tap T_2 in response to data provided by the signal-power detector/processor 48 to minimize signal power at the feed-forward path splitter 38 when the SPDT switch 46 is set to connect the input of the signal-power detector/processor 48 to the second output of the feed-forward path splitter 38 and to minimize the intermodulation received by the intermodulation receiver 44 when the SPDT switch 46 is set to connect the input of the signal-power detector/processor 48 to the output of the intermodulation receiver 44;

a feed-forward signal path gain and phase adjuster 40, the input of which is connected to the first output of the feed-forward path splitter 38, the feed-forward signal path gain and phase adjuster 40 having a gain-control input tap T_3 and a phase-control input tap T_4 ;

a correctional amplifier 42, the input of which is connected to the output of the feed-forward signal path gain and phase adjuster 40 and the output of which is connected to the second input of the first main path coupler 30, the main signal path delay element 28 having a delay approximately equal to the delay in the correctional amplifier 42;

an intermodulation detector/processor 50, the input of which is connected to the output of the intermodulation receiver 44, the intermodulation detector/processor 50 configured to extract and process data from the signal presented to its input indicating how to steer the gain-control input tap T_3 and the phase-control input tap T_4 to minimize the signal presented to its input;

an intermodulation gain controller 56, the input of which is connected to the first output of the intermodulation detector/processor 50 and which steers the gain-control input tap T_3 in response to data provided the intermodulation detector/processor 50 to minimize intermodulation received by the intermodulation receiver 44; and

an intermodulation phase controller 58, the input of which is connected to the first output of the intermodulation detector/processor 50 and which steers the phase-control input tap T_4 in

response to data provided the intermodulation detector/processor 50 to minimize intermodulation received by the intermodulation receiver 44,

and in which upon startup of the feed-forward amplifier 10, the SPDT switch 46 is set so as to connect the feed-forward path splitter 38 to the signal-power detector/processor 48 until the total power in the feed-forward path is minimized and the intermodulation received by the intermodulation receiver 44 is minimized, and then set so as to connect the intermodulation receiver 44 to the signal-power detector/processor 48.

3. A method for operating a feed-forward amplifier having a signal cancellation loop and a intermodulation cancellation loop, comprising:

on startup, operating the feed-forward amplifier so that the signal cancellation loop is balanced so as to minimize signal power in the feed-forward path; and

then, operating the feed-forward amplifier so as to minimize intermodulation at the output of the feed-forward amplifier.

4. A method for operating a feed-forward amplifier having a signal cancellation loop including a first gain and phase adjuster, a main amplifier forming a portion of a main signal path, and a feed-forward signal path output for providing a feed-forward signal, and an intermodulation cancellation loop connected to the feed-forward signal path output, including a second gain and phase adjuster, a correctional amplifier, and a correctional coupler for coupling the output of the correctional amplifier to the main signal path downstream of the main amplifier, comprising:

steering the first gain and phase adjuster so as to minimize signal power at the feed-forward signal path output and the second gain and phase adjuster so as to minimize intermodulation downstream of the coupler;

and then, when the signal power at the feed-forward signal path output and the intermodulation downstream of the correctional coupler reach minimums,

steering both of the gain and phase adjusters so as to minimize the intermodulation downstream of the correctional coupler.